BULLETIN

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THE BULLETIN IN BRIEF.

Two thousand persons at Museum meeting hear speech of M. Pelterie and see motion picture of a flight to the moon.

M. Pelterie outlines his program and predicts success of interplanetary flights.

Dr. Lyons injured in explosion of altitude rocket.

Problems in construction of a space rocket discussed by Mr. Fitch in report under research program.

Motion picture supervised by Professor Oberth shows features of a rocket flight through space.

Professor Oberth, predicts use of rockets in future warfare.

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TWO THOUSAND AT MUSEUM MEETING.

The extent of New York's interest in the possibility of interplanetary flights was attested on January 14, when 2,000 persons attended a public meeting under the auspices of the Society at the American Museum of Natural History to hear M. Esnault Pelterie lecture on the subject and see the first American showing of a film scientifically depicting a flight to the moon. Unfortunately M. Pelterie, who is the author of "L'Astronautique," and one of the leading authorities of that new science, was prevented from attending the meeting by a severe cold which confined him to his hotel room. His speech, an abstract of which is contained in the Bulletin, was read by G. Edward Pendray, vice-president of the Society. David Lasser, president of the Society, introduced Dr. H. H. Sheldon, head of the physics department of New York University, who gave a verbal sketch of M. Pelterie and his ideas, and incidentally vouched for the scientific possibility of interplanetary flights. The size of the crowd, exceeding the capacity of the large Museum auditorium, made it necessary to repeat the entire program for the benefit of those who were unable to get in at the start of the meeting and who waited in line for almost two hours. The motion picture which was included in the program was the UFA film, "A Girl in the Moon," the scientific portion of which was supervised by Professor Hermann Oberth, Hungarian rocket expert.

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M. PELTERIE DESCRIBES INTERPLANETARY FLIGHT.

(The following is an abstract of the address of M. Robert Esnault Pelterie, author of "L'Astronautique," read at the public meeting sponsored by the Society at the American Museum of Natural History on January 14, 1931.)

The American Interplanetary Society was good enough to ask me to use my present visit to America to give under its auspices a lecture on interplanetary travel, its future and its possibilities. Naturally the first question that comes to mind is - what is the interplanetary problem? What is it that we, who call ourselves astronauts, wish to do, and what are the difficulties? I think we can understand the answer to this question best when we picture our position in the universe. We reside on a little speck of dust called the earth. Ninety-two million miles away is the sun that warms us and keeps us alive. We are slaves of the sun, but the earth has a slave of its own - its satellite, the moon, that circles about the earth at a distance of 240,000 miles every 28 days. It is the moon that is to be the terminus of the first interplanetary journey.

There is one thing possessed in common by all these bits of dust and that is gravitation. We are held down to the surface of the earth, the moon is held in its orbit about the earth, the earth in its orbit about the sun, all by the power of universal gravitation. In order to escape from the earth we must be able to oppose that gravitation, which is responsible for what we call weight, and lift ourselves 240,000 miles. Surely this is a gigantic task. For consider, the airplane has been able to lift man only eight miles and the balloon has ascended without man only 22 miles. We propose now to increase our range more than 10,000 times. Fortunately however one thing aids us. This thing that holds us close to the embrace of mother earth will let go of us if we pull hard enough. It diminishes by the square of the distance as we draw away. Although I must have force to lift my full weight at the surface of the earth as I go further and further away I need less and less force to keep myself away from the earth.

Now we know that if we throw an object into the air it rises until its velocity is overcome by the earth's pull and then falls back. If we increase the force with which we throw it - in other words increase the initial velocity - it will rise higher and higher before falling back. And finally if we throw it hard enough we find that the object can forever escape from the earth. It will never come back. That speed with which we must start a projectile away from the earth to allow it to escape from the earth's clutches is the speed we must attain in interplanetary travel. It can easily be calculated. It is 6.664 miles per second, about eighty times the speed of the fastest airplane.
. . . .

Eliminating these three modes of transportation (airplane, balloon and cannon projectile) we see that we need something that does not require air, and also that can be started gradually. These requirements are met almost ideally by the rocket. Experimenters, such as your own Professor Goddard, have found that the rocket develops its greatest efficiency in a vacuum . . . .
The rocket is familiar to you as the sky rocket. It is an engine of this kind that astronauts propose to use to travel into airless space hundreds of thousands of miles away from the earth. The rocket that we must use should be designed anew. We must use instead of the ordinary black powder in your sky rocket a fuel perhaps a hundred times more powerful. The rocket must also be immensely more refined. Its means of control must be created, so to speak, from the ground up.

We must not only find fuels tremendously more powerful than have been ever used, but they must be fuels that serve our special purpose, and fuels that we can control. We must have fuels that are dependable, so that we can tell exactly what they will do under given circumstances. For in the space flight there is no such thing as getting out and walking when your motor stalls.

There are many other considerations which I wish to present to you, to have you understand the space flight, before I pass on to my own work and plans. In the first place we must make provisions in the ship that is to go into space for supplying our air to breathe, our heat, our food and other necessities for comfort. We must have instruments that can serve for navigation in those regions that have never known the presence of man. For not only, as I stated, must we acquire a speed of 6.664 a second, or 24,000 miles an hour, to keep us from falling back to earth, but we must not exceed that speed. If we do we are likely to go shooting off into space and never come back. You must realize that in outer space there is no air to slow down our speed by its resistance. There are also no sign posts to tell us where we are. We must, like the sailors of five hundred years ago, depend on luck or provide instruments that will help us steer and control our course. Therefore the problem of building a space ship means not only finding adequate fuels, but also controlling those fuels, finding light but intensely strong materials with which to construct the ship, making instruments, providing conditions that make life possible for crew and passengers. This, as you will perceive, is a tremendous task, and the serious scientist who realizes and understands these difficulties, each one being a great job of itself, will not predict how soon all of them will be solved.

My own method of approach to this problem of interplanetary travel was to first lay firmly the theoretical foundation, in other words to work out mathematically the nature of the problem. My results are in my book "L'Astronautique," which tells what must be done with men, materials and money in order to accomplish the final end of reaching the moon and the other planets. This book represents many years of work, for I had to go off into an entirely new field, and calculate on things that men had never calculated on before. My own theoretical foundation has therefore been laid and I am ready now, as soon as conditions are fitting, to begin experimental work.

Experiments on rockets are very costly. It is a work of precision, not only in the making and handling of the fuels but in the building of the rocket itself, and a man would be foolish to start off on these experiments unless he had sufficient funds assured to carry his ideas out to a conclusion. I do not claim I could build a ship to travel to the moon tomorrow or ten years from now. There are too many things which must be done first to allow any predictions. It is like trying to predict how long it would take to build a railroad over a great stretch of ground when we can see only a few miles. A conservative engineer would say that he can predict how long it would take to build the part of the line which he can see, and that as he goes on will see more ground, enabling him to better his estimate. I have now gone far enough to know that with $40,000 with which to carry to completion experiments on fuels that I have in mind, I can within two years build a rocket to travel upward 100 miles, practically to the limit of the earth's atmosphere. Such a rocket would carry instruments of precision, cameras and devices to tell me just what the constitution of the upper air is and to gather other information of great value to science. This rocket would also serve to give me further actual data on its operating possibilities, and I would discover things that could be done to extend its range and efficiency.

With the benefit of perhaps months of experimentation with a successful 100-mile rocket I might try for higher altitudes or begin work on a more ambitious scheme, such as the shooting of automatically controlled postal rockets between various towns or countries, such as between southern France and Africa. This would entail solving great problems in the control of the speed, direction and landing of them, but as time went on and they became more and more perfected I would extend their range so that shots would ultimately be tried between Paris and northern Africa. Step by step I would see the rocket perfected in practice

until finally at the end of five years of labor, I believe that with a fund of $1,000,000 I could build a rocket to travel between Paris and New York in half an hour. This rocket, carrying mails at first and later passengers, would leave its terminal, rise into the upper strata of the air up to 800 miles above the earth, and crossing the Atlantic, descend in a long gentle glide to its destination. Such great speeds as 7,000 to 8,000 miles an hour necessary to this flight are possible at that level since the only bar to speed in a level flight, the resistance of the air, has been cut to practically nothing. Naturally my estimate of the time required to build a transatlantic rocket cannot be as exact as that for the 100-mile rocket . . . . . . All that I can say is that as a result of 25 years of study of this problem, and calling into play all my experience with other means of transportation such as the automobile and airplane, I believe it could be done.

As for the third step, the building of a space ship, naturally an estimate of that would be even more inaccurate. As a careful scientist I should not even set a date for such a fulfilment . . . . . Though I have full faith in the final successful outcome of the interplanetary idea, for the present let us get to work to achieve the primary aims. We will bring the moon flight closer in that way than by making prognostications that we would be obliged to deny a year or two from now. Now, you will ask, what will be the nature of the moon journey? What will it consist of and what will be some of our sensations on the way?

In the first place let me say that the journey, the planning of it, must be a rigid, exact matter. We must start our journey at a predetermined moment, pursue a course which has been plotted through the heavens very exactly, and aim at a point in the heavens where the moon will be when we get there. In other words we do not shoot at the moon, but like a hunter shooting at a flying bird, we aim ahead so as to catch it on the wing. All of this means the most exact calculations. As I have stated we will not start off with the necessary speed of seven miles per second, for that would mean that the terrific pressure of the acceleration would crush us. We must start off slowly, so that while we are passing through the atmosphere our speed is increasing as rapidly as possible. Our necessary speed is reached after eight minutes of travel, when we are 1,200 miles above the earth. Now when I say we start gradually I do not mean we start as slowly as we wish. For the most efficient use of fuel our speed must be increased as fast as the human body can stand it. From our common experience this increase of speed or acceleration will be quite great. We will probably feel it as a weight on us of three times our normal weight. We cannot stand up during this period. We must lie down to distribute over our body this load of three or four hundred pounds. But after the eight minutes are over most of the power can be shut off. We are then free of the earth's pull, and without additional power we can travel on to the moon.

After this eight minutes of tremendous weight there will follow a condition almost the opposite, a period of complete weightlessness. We will have the sensation, truly terrifying, of falling through space, even though our feet will be on the floor of the cabin. We cannot walk as we do on earth, for we would float immediately to the roof of the cabin and hang there. We must use straps to maintain our position and dignity. We could not drink as we do ordinarilly. Water, having no weight, would not flow from its container. We would have to provide means of throwing it out, or squeezing it out . . . .

As we approach the moon we will have to slow down our speed, for it is now too great to permit us to circle the moon as we wish. If we did not slow down we would shoot past the moon to go into endless space. So we turn the interplanetary car end for end with the tail now forward, and start the rockets firing again. They are now being used to slow down our speed. As we near the moon we swing about it and circle its desolate crater-pitted surface . . . . . We again turn our rocket about and now, nose first we set our course for the earth. The moon's

attraction is weak as compared with that of the earth and soon we are out of the moon's influence and into the earth's, beginning a 220,000 mile drop. Our speed becomes greater and greater, until it reaches that with which we left the earth, more than six miles a second. Once more as we near the earth we must turn our rocket about and slow down so that we can enter the earth's atmosphere at a reasonable velocity. We slide into our atmosphere gradually, for our speed is still tremendous and we do not wish to burn up. But deeper and deeper we sink into the layers of air until finally in a long soaring glide we slide down to a landing place, perhaps aided in the last few miles by a huge parachute which brings us gently to the earth.

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THE CONSTRUCTION OF A ROCKET VEHICLE.

(Abstract of a report by Clyde Fitch to the American Interplanetary Society at meeting of January 16, 1931.)

Of all the phases of space flight perhaps the one that has received the least attention is the actual construction of the rocket vehicle. When we realize the vast amount of work required to build a rocket ship capable of carrying a man off the earth and project him into outer space, we can readily understand why this part of the problem has been delayed. It is true that the few scientists now seriously engaged in rocket design have already solved many of the problems of construction; but most of their work has been of a theoretical nature, backed up by only a few practical tests on small rockets of more or less experimental type. Before the actual construction of a manned rocket can begin many tests have to be made. We know the velocity required to leave the earth; we know the amount of various fuels now available that are required to attain this velocity; we know how much acceleration the human body can stand; but we don't know the best form of construction through which these theoretical ideals can be realized. Fortunately none of these tests is insurmountable. They can all be conducted with apparatus and materials now available in suitable laboratories equipped for the purpose. In fact the work already done in this direction, although small, gives considerable data on which the construction of a practical manned rocket can be based.

The rocket motor is one of the most simple machines known. In general its construction consists of exhaust nozzles, combustion chambers, fuel containers, pumps, and observation chamber with the necessary pay load and instruments. Consequently its construction evolves itself into the selection of the proper size and shape of the parts and the materials that will withstand the mechanical stresses and the temperatures encountered.

Using liquid hydrogen and liquid oxygen, the temperatures encountered in rocket construction would range between minus 252 degrees C., which is the temperature of liquid hydrogen, to perhaps 3500 degrees C., the temperature obtained in an electric arc furnace. Aside from the high temperatures encountered in the combustion chamber, heat will be generated in the shell of the rocket due to the air friction as it passes through the atmosphere. Fortunately, the rocket starts at low speed and gradually accelerates - 100 feet per second, and it passes out of the denser portion of the atmosphere before excessive velocity is attained. Furthermore the liquid fuel is contained just inside of the outer shell of the rocket, and this, through evaporation, would keep the ship cool. In the step rocket the greater portion of the ship is shot away about the time it leaves the atmosphere -- about three minutes after the ship leaves the ground. If it does develop much heat no great harm will be done. The second rocket can continue the journey in a cool condition.

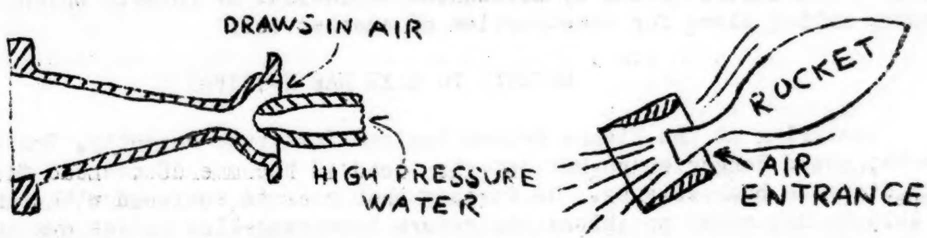
Knowing the temperatures encountered the next step is to select the materials that will stand these temperatures. The greatest problem is in selecting materials for the low rather than the high temperatures. Professor Oberth gives us the most information on this subject. Due to the brittleness of ordinary structural materials, such as steel, at low temperatures, other materials must be used. In this respect tensile strength is more important than elasticity as the stresses will be uniform. No sudden shocks or explosions, it is hoped, will occur. For the liquid oxygen container, copper is recommended. Copper at a temperature of 182 degrees below zero C. has a tensile strength of 42,500 pounds per square inch. Structural steel at normal temperatures has a tensile strength of 60,000 pounds per square inch. The addition of a little zinc will increase the tensile strength. Alloys of copper with zinc, iron, nickel and manganese may be used. Under no condition should iron or steel be used. It is not only brittle at low temperatures but it oxidizes rapidly at high temperatures.

For the liquid hydrogen container lead is recommended. Lead alloyed with copper up to 40 percent has a tensile strength of 64,500 pounds per square inch at a temperature of 253 degrees below zero C. Oberth also mentions a secret material which has a tensile strength at the temperature of liquid oxygen equal to its tensile strength at normal temperatures, and an elasticity at low temperatures scarcely below that of copper. The tensile strength of this secret material is 194,000 pounds per square inch. This material was developed by A. B. Scherschevskys, and while its formula is kept secret it will be revealed to anyone who seriously undertakes to construct a large rocket.

For the atomizers through which the liquid fuel is sprayed into the combustion chambers, Oberth recommends silver, which does not oxidize and which remains elastic at low temperatures. For the combustion chamber very little or no information is given in the available literature on rockets regarding the best materials to use. However considerable research has been done on combustion chambers in gas turbines. In the combustion chambers of gas turbines, some of which have been running for several years at temperatures of 1,500 to 2,000 degrees C. a carborundum lining is employed. Carborundum is a carbide of silicon and is a product of the electric furnace. It will without doubt provide an excellent lining for the exhaust chambers of the rocket.

The success or failure of the rocket ship depends upon the design of the combustion chamber and the exhaust nozzles. Here the entire action takes place, and unless these are properly designed to get the greatest efficiency from the fuel the ship will probably crash back to earth. There is little available information on the design of combustion chambers and exhaust nozzles of rockets but, as stated before, considerable research has been done on gas turbines. The results of some of this work show that the combustion chamber should be constructed to stand as high a temperature as possible -- somewhere in the neighborhood of 40 atmospheres; the cross section of the chamber should be about 10 times the end of the nozzle -- in which case the velocity of the gases in the chamber will be about 1/40th that of the nozzle velocity; the nozzle cone should taper at an angle of about 10 degrees, and the chamber length should be 5 to 10 times its diameter. A small combustion chamber can be made to withstand much greater pressures proportionately than a large one. The length of the nozzle will be rather short, as after the expansion has reached a certain stage where maximum velocity is obtained an extension of the nozzle would decrease efficiency by adding unnecessary weight to the ship. Therefore the rocket will have a honeycomb arrangement of small combustion chambers and nozzles instead of one or two large ones -- and this is in agreement with the ideas set forth by Oberth and others on rocket design.

Before leaving the subject of nozzles it might be well to mention one more type -- the water jet nozzle. Here water at high pressure passes through a divergent nozzle, around the throat of which air is allowed to enter. The force of the water sucks the air in at an efficiency, so far as pumping the air is concerned, of 90 percent! It is suggested that a jet of the products of combustion at high pressure develop its full kinetic energy in a divergent nozzle. This would then be used to draw in 4 or 5 times its weight of air. It is known that at low speeds in air the efficiency of the rocket is very low. By this method the exhaust gases would act on the air so as to draw it in at high speed, thus gripping the air, hurling it back and pushing the ship forward in



the same manner that an airplane propeller throws air back to get the forward thrust. This method might increase the efficiency of rockets at low speeds through air considerably and make the rocket plane a reality. It would be a simple matter to make a test on a small sky rocket, such as one used for Fourth of July celebrations.

The question of refrigeration, or cooling the combustion chamber by outside means so as to operate it at temperatures which could be more safely handled has been answered by the gas turbine experimenters. For greatest efficiency the expansion of the gases should take place adiabatically -- that is, without loss of heat. Should heat be lost while the gases are expanding through the nozzle the velocity will be reduced. As a subterfuge for cooling -- without loss of heat -- a water spray is injected into the exhaust nozzle. The water immediately evaporates and absorbs large quantities of heat, thereby cooling the entire system. This process at the same time expands the water along with the gas, and the heat absorbed by the water is converted into useful energy.

The pressure developed in the combustion chambers is very great -- 20 to 50 atmospheres -- and probably greater with more potent fuels than those on which tests have already been made. This means that the liquid fuels have to be forced into the chambers at greater pressures. Turbine pumps can only develop pressures of 20 to 25 atmospheres and consequently cannot be used for rockets. With reciprocating pumps pressures up to 60 atmospheres are possible and if necessary it is quite likely special pumps could be developed which would create greater pressures. This is one of the most serious difficulties in the entire construction of the rocket. In the Model E two-step rocket of Oberth there are approximately 50,000 cubic feet of liquid fuel which has to be pumped through the atomizers in the fuel chambers -- all within the short time of seven minutes! It is doubtful if small light-weight pumps could be designed to do this work. If not the fuel tanks would have to be designed for high pressure and the evaporation pressure of the fuels employed to force the fuel into the combustion chambers. This makes the firing of a rocket ship a very dangerous undertaking. Some device could probably be developed whereby the pressure of evaporation could be controlled in a small auxiliary tank to develop the correct pressure. Great pressures on the main tanks cannot be used, as the tanks would have to be unusually strong and heavy.

ALTITUDE ROCKET EXPLODES.

The large two-step rocket constructed by Dr. Darwin Lyons, New York physicist, which was described in the Bulletin for January, was destroyed early this month by an explosion which injured the inventor and several mechanics. The accident occurred atop Mount Redorta, a 10,000-foot peak in the Italian Alps, from which point Dr. Lyons had hoped to send it to a height of 70 to 90 miles. First reports that a mechanic had been killed apparently were unfounded. The rocket was powered by liquid oxygen and benzol, and equipped with a gyroscope stabilizer, and scientific instruments for the exploration of the upper atmosphere. Dr. Lyons, who has now been injured twice by accidental explosions of rockets which he built, is already making plans for construction of another one.

ROCKETS TO MAKE WAR HORRIBLE

Lecturing at the Vienna Meteorological Institute recently, Professor Hermann Oberth, noted Hungarian rocket expert, pictured the use of rockets for terrible long distance bombardments. He foresaw that rockets equipped with cameras would be able to map enemy positions and return boomerang-like to its own army. By an extension of its use and range, a nation of one side of the earth could bombard an enemy on the other side with "a murder-our rain of rockets carrying poison gas containers which could exterminate entire populations. Airplanes, he stated, will be obsolete as compared with rockets in a few years. Every War Office, with the exception of Germany, Oberth states, is feverishly experimenting with death dealing rockets. He himself is carrying on similar experiments but he hopes that by showing how horrible a weapon they can become, that they will act in the end as a deterrent to warfare.

A vivid and scientifically accurate motion picture of conditions that will prevail in the interior of a rocket ship flying from the earth to the moon or another planet is contained in the UFA film, "By Rocket to the Moon", which had its first showing in America at a meeting sponsered by the Society on Janaary 14 at the American Museum of Natural History. The picture has since been released for commercial showings, having its first run at the Cameo Theatre in New York. Supervised by Professor Hermann Oberth, Hungarian experimenter on rockets, the picture shows vividly what a space rocket will look like both inside and outside. After a rather impressive start from a body of water in which it was floated, glimpses of the rocket flaming through interplanetary space are given. The most interesting portions of the picture, however, are the scenes inside the space traveler, showing the curious effects occasioned by the lack of any gravitational force. The passengers are shown gingerly walking about by hooking their feet in straps on the floor. One of the passengers, a boy, misses his footing and floats gently to the ceiling. In order to get water from a bottle it is necessary to sling it out and then pick up with the hand the drops as they hang suspended in the air. Other interesting shots show the earth and the moon as they appear from the space ship at various stages of its journey.

Meetings of the New York members of the American Interplanetary Society are held on the first and third Fridays of each month at the American Museum of Natural History, 77th Street and Central Park West. Persons interested in the aims of the Society are invited to attend and to write to the secretary, C. P. Mason, 302 West 22nd Street, New York City, for information about the various classes of membership, including active, associate and special, which are open to men and women who possess the necessary qualifications.

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